

# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT Article 36 and Rule 70)

REC'D 28 APR 2005

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Applicant's or agent's file reference P03008	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/NO2004/000070	International filing date (day/month/year) 12.03.2004	Priority date (day/month/year) 17.03.2003
International Patent Classification (IPC) or both national classification and IPC C25C3/08		
Applicant NORSK HYDRO ASA et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
 

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:
 

I    ☒ Basis of the opinion

II   ☐ Priority

III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability



IV   ☐ Lack of unity of invention

V    ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

VI   ☐ Certain documents cited

VII ☐ Certain defects in the international application

VIII ☐ Certain observations on the international application

Date of submission of the demand  13.10.2004.	Date of completion of this report  27.04.2005
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Mizera, E  Telephone No. +49 89 2399-8580 <div style="text-align: right;">  </div>

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/NO2004/000070**

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

1-13 as originally filed  
3a filed with telefax on 16.03.2005

**Claims, Numbers**

1-14 filed with telefax on 16.03.2005

**Drawings, Sheets**

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.
4. The amendments have resulted in the cancellation of:
- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. **PCT/NO2004/000070**

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	1-14
	No: Claims	
Inventive step (IS)	Yes: Claims	1-14
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-14
	No: Claims	

2. Citations and explanations

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/NO2004/000070

AS TO BOX V:

1. The following documents are cited:

D1: WO 87 00211 A1

D2: WO 01 94667 A1

D3: GB-A-2 076 428

D4: US-A-4 222 841

2. All of documents D1 to D4 disclose ducts for the throughflow of a medium and an outer circuit, arranged in, or constituting at least a part of the lining of an electrolysis cell for production of aluminium metal. In all of these documents the ducts, however, are formed from metals, embedded into the cell lining.
3. Claim 1 requires the ducts to be 'formed directly in' the cell's lining, and thereby constituting an integral part of the structural element (3). In all of documents D1 to D4 the ducts have been formed **before** they are embedded into the lining.
4. For this reason claim 1 and claims 2-14, depending on this claim, are novel under Art.33(2) PCT.
5. The design according to claim 1 avoids a gap between the metallic structure, which contains the coolant, and the lining material. The heat transfer between duct and lining is therefore improved.
6. Further the use of ducts consisting of material that is prone to corrosion in the aggressive environment of an aluminium electrolysis cell is avoided. The non-metallic material, in which the ducts are directly formed, is resistant to corrosion.
7. This supports the inventive step, required by Art.33(3) PCT.

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electrolysis cell and make cell operation, i.e. layer formation in the side lining, more independent of the current intensity supplied to the cell. The patent does not describe which materials are to be used in the heat exchanger, but it stipulates that they must be resistant to the corrosive atmosphere in the cell and also be oxidation-resistant as air is proposed as a coolant, among other things.

WO 83/01631 refers to a device for heat exchange of hot exhaust gases from closed electrolysis cells. The heat in the exhaust gases is used to preheat the feed flow of aluminium oxide to the electrolysis cell, and the regulation of the side layer's thickness in the cell as such is not an issue. WO 87/00211 (see also NO 86/00048) from H-Invent describes a principle and a method for heat recovery from aluminium electrolysis cells. The publication describes metal plates with spiral ducts for extraction of heat from the side lining. Various coolants can be used. Among others, helium is mentioned in particular in the patent. The hot exhaust gases from heat exchange in the side lining can be used for energy production by driving an expansion machine that, in turn, drives an electric generator. The material in the heat exchanger plates is made of metal. In order to protect these plates against liquid electrolyte, an external layer of fireproof material, for example carbon, is used against the electrolyte. One problem with this solution will be ensuring good contact between the heat exchanger plates and the external cladding of fireproof material. Poor contact between these two layers will reduce the effect of the heat exchanger installation and thus lead to reduced heat recovery and reduced control of the side layer's thickness in the electrolysis cell.

Norwegian patent applications NO 20002889, NO 20014874 and NO 20005707, international patent application WO 02/39043 and Norwegian patent NO 312770, all from Elkem Aluminium, describe a different version of the previously mentioned heat pipes for cooling aluminium electrolysis cells, among others. The patents describe heat pipes for which sodium metal is mentioned in particular as a coolant. The side walls of the electrolysis cell are thermally insulated

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Amended Claims

1. An arrangement of one or more structural elements for use in an electrolysis cell (5) for production of aluminium metal from a component containing aluminium in a fused salt, where the component containing aluminium is mainly alumina and the fused salt is mainly based on mixtures of NaF and  $AlF_3$  and  $CaF_2$ , possibly plus alkali and alkaline earth halides,

characterised in that

the structural element(-s) (3) is arranged in the cell's lining, or constitute at least a part of it, where the structural element(-s) (3) is designed with ducts (2) formed directly in it and thereby constituting an integral part of said element(-s) (3), said ducts being arranged for the through-flow of a medium and further designed so that they can be used for active control of the side layer's (10) thickness and heat transfer through the cell lining, and where said ducts are connected to an outer circuit (8, 16, 17).

2. An arrangement in accordance with claim 1,

characterised in that

the ducts (2) are designed with a mainly circular cross-section with a smooth (13), star-shaped (12), spiked (14) or sinusoidal (15) surface.

3. An arrangement in accordance with claim 1,

characterised in that

one or more structural elements (3) are arranged in the side lining of the electrolysis cell to cool the electrolysis cell (5).

4. An arrangement in accordance with claim 1,

characterised in that

one or more structural elements (3) are arranged in the side lining of the electrolysis cell to control the layer thickness and/or for energy recovery.

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5. An arrangement in accordance with claim 4 in which energy is recovered from the electrolysis cell,

characterised in that

the energy is used to preheat alumina that is fed to the cell.

6. An arrangement in accordance with claim 1,

characterised in that

the electrolysis cell (5) comprises carbon anodes and/or inert anodes.

7. An arrangement in accordance with claim 1,

characterised in that

the electrolysis cell (5) comprises electrodes arranged vertically and/or horizontally.

8. An arrangement in accordance with claim 1,

characterised in that

the structural elements (3) are made of ceramics based on carbon, carbides, nitrides, borides or oxides or mixtures of these materials.

9. An arrangement in accordance with claim 1,

characterised in that

the structural elements (3) are made of carbon, silicon nitride, aluminium nitride, silicon carbide, silicon oxynitride, silicon aluminium oxynitride, titanium diboride, zirconium diboride or mixtures of these materials.

10. An arrangement in accordance with claim 1,

characterised in that

the structural elements (3) are made by dry or wet pressing, slip casting and/or stamping and the ducts (2) are made by means of grooves in plates that are subsequently glued together before sintering.

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11. An arrangement in accordance with claim 1,  
characterised in that  
the structural elements (3) are made using the so-called lost wax method, burnout material and/or cutting out plates for subsequent assembly in accordance with the laminar method.

12. An arrangement in accordance with claim 1,  
characterised in that  
the structural elements (3) are made using production methods that ensure gastight elements made by optimising the green body and/or glazing/impregnation of the finished material.

13. An arrangement in accordance with claim 1,  
characterised in that  
the structural elements (3) are provided with sleeves and/or transitions (18) for connection to an outer circuit.

14. An arrangement in accordance with claim 10,  
characterised in that  
the structural elements (3) are made using glue based on refractory cements, silicon metal, etc. to join the parts before sintering and to contribute to the elements being gastight after sintering.